LA-UR-20-26983
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Title: Suggestions for SG-50 Layer-1 Templates of (n,f) Cross Sections, PFNS and Average Prompt-fission Neutron Multiplicities and Evaluation Needs

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Intended for: WPEC SG-50 meeting, 2020-09-14/2020-09-15 (Paris, France)
Web

Issued: 2020-09-08

Suggestions for SG-50 Layer-1 Templates of (n,f) Cross Sections, PFNS and Average Prompt-fission Neutron Multiplicities and Evaluation Needs

D. Neudecker SG-50, Kick-off meeting, 9/15/2020

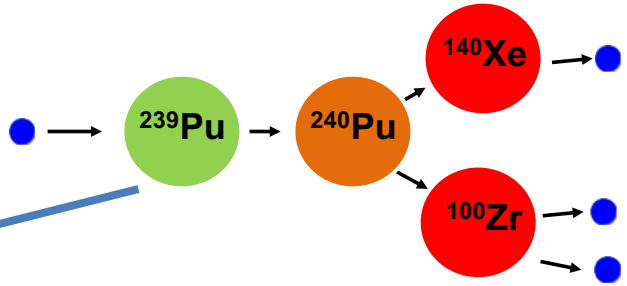
Thanks to: all co-authors on the measurement UQ template paper, Chi-Nu, TPC, USU paper, PFNS CRP, …

These three observables could be worth studying in SG-50 as they form the fission-source term for criticality simulations.

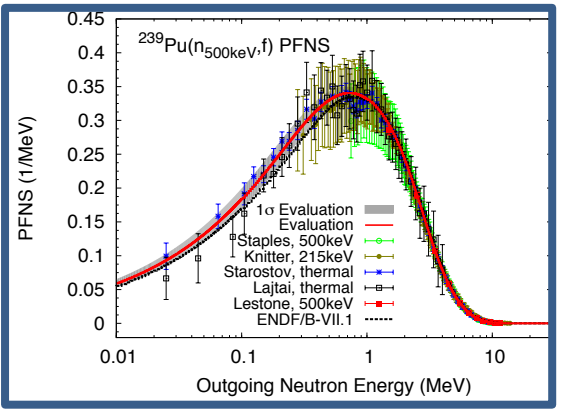
$$\Omega \cdot \nabla \psi(\boldsymbol{r}, E, \Omega) + \Sigma_t(\boldsymbol{r}, E, \Omega)\psi(\boldsymbol{r}, E, \Omega)$$

$$= \int_0^\infty \int_{4\pi} \Sigma_s(\boldsymbol{r}, E' \to E, \Omega' \to \Omega)\psi(\boldsymbol{r}, E', \Omega')d\Omega' dE'$$

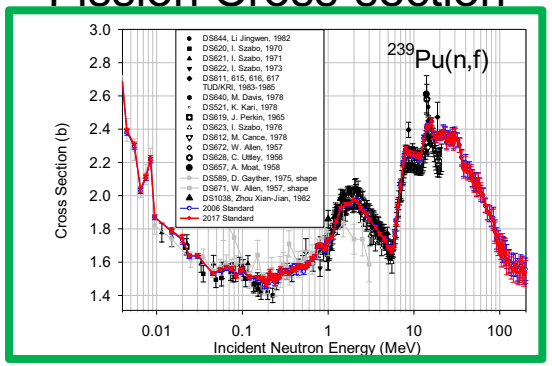
$$+ \frac{1}{k} \frac{\chi_f(E)}{4\pi} \int_0^\infty \int_{4\pi} \bar{\nu}_t(\boldsymbol{r}, E') \Sigma_f(\boldsymbol{r}, E', \Omega') \psi(\boldsymbol{r}, E', \Omega') d\Omega' dE'$$



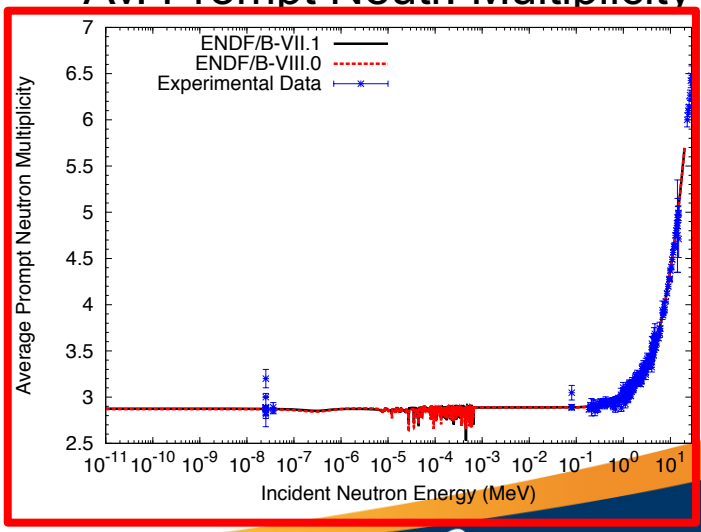
Prompt Fiss. Neutr. Spectrum



Fission Cross-section

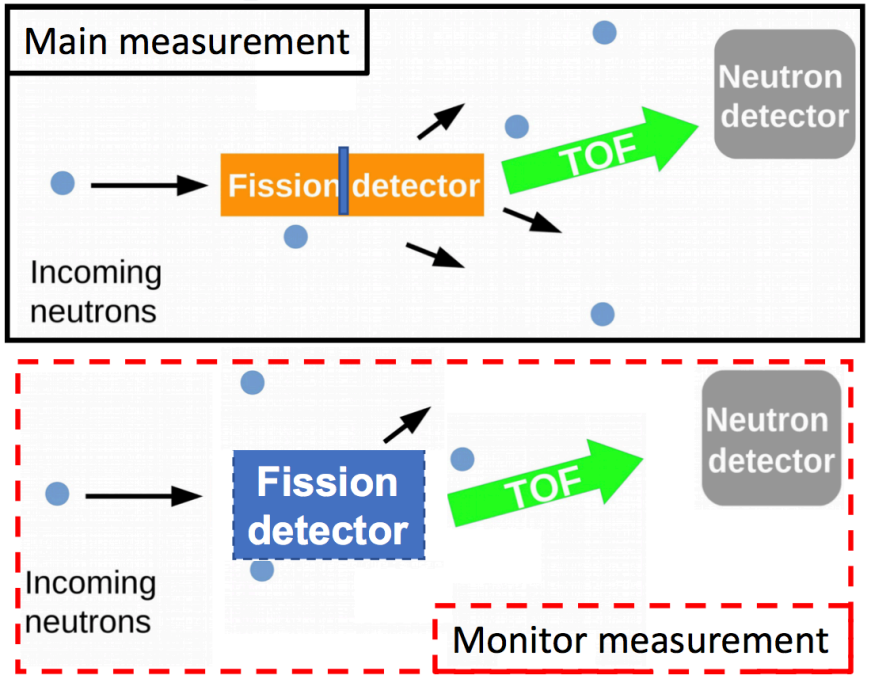


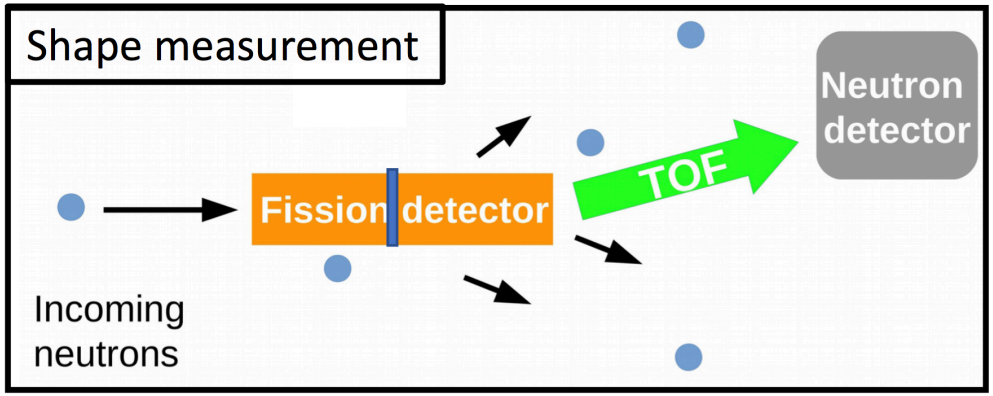
Av. Prompt Neutr. Multiplicity



In PFNS measurements, one usually determines the shape or obtains ratio data:

A PFNS (Prompt Fission Neutron Spectrum) gives the energy distribution of neutrons emitted after scission and before the on-set of beta-decay.





As an evaluator I would need from PFNS measurements the following information:

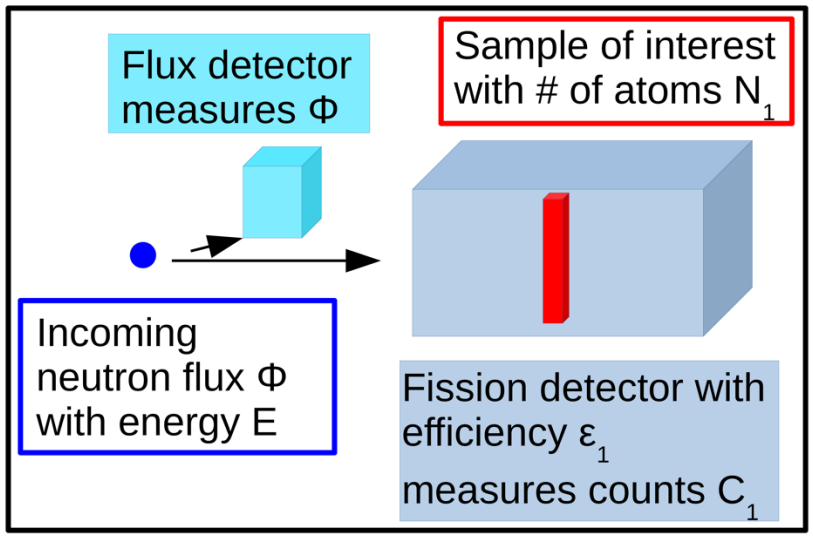
Data: E_{inc}, E_{out}, PFNS/ ratio data, Maxwellian temperatures, TOF length, time resolution (or energy unc.), if monitor used: monitor observable + nuclear data if shape data are given, observable measured (ratio, shape)

For UQ: what type of measurement (shape, clean/ indirect ratio?), TOF-length uncertainty, counting statistics unc., background unc., detector-response unc., multiple scattering and attenuation unc., deadtime unc., nuclear-data unc., angular-distribution unc., impurity unc.

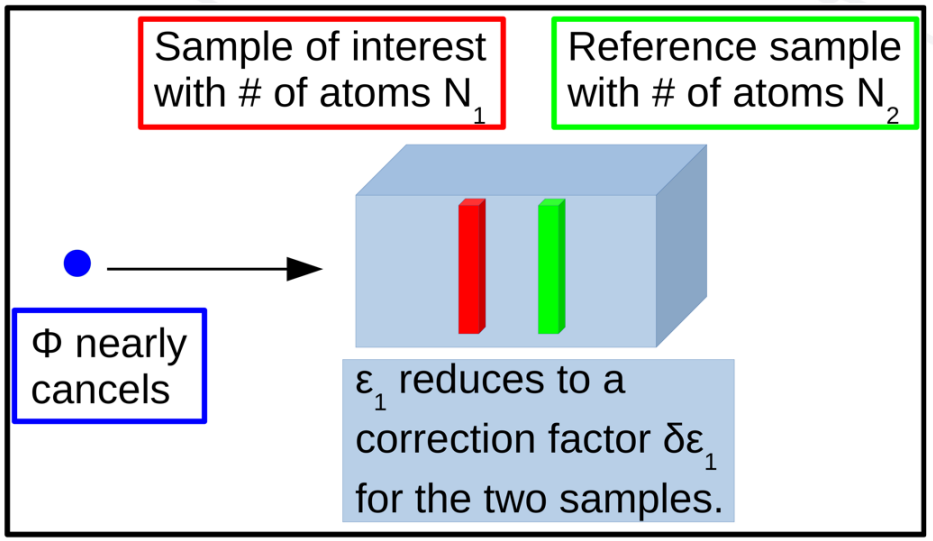
For background information: reference, impurity levels in sample, correction factors, sample thickness, known issues, known correlations to other data sets, what was corrected (background, multiple scattering, detector response, random coincidence, angular distribution, forward boost, deadtime, impurities, neutron-flux variations), fission/neutron-detector types, gas in detector, pressure in detector, neutron-producing reaction, incoming-neutron source, target-backing material/ thickness, target diameter, number of samples, target mass, angular coverage, facility, institute, author, methods (incident/outgoing-neutron energy determination, background, multiple scattering, detector response, impurities, sample fabrication)

An (n,f) cross section measures the probability of fission taking place:

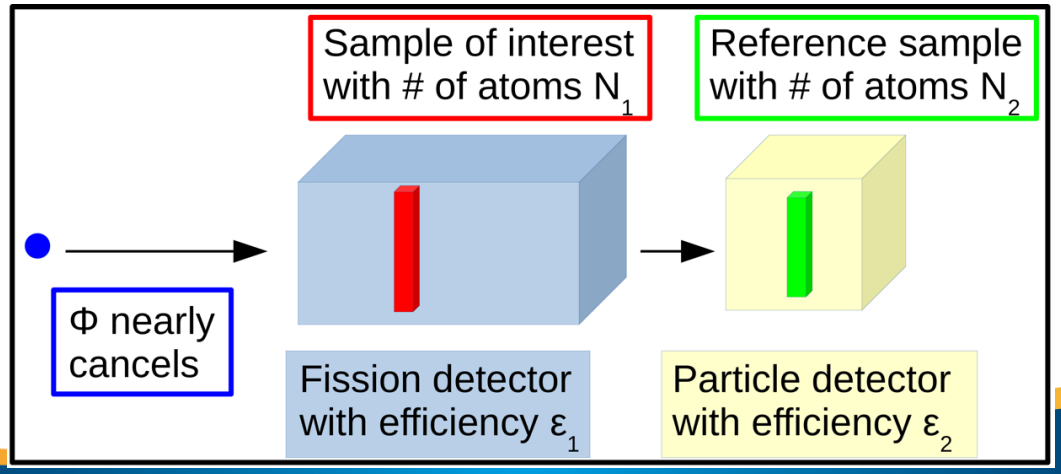
Absolute measurement



Clean ratio measurement



Indirect ratio measurement (e.g., to $^{10}B(n,a)$)



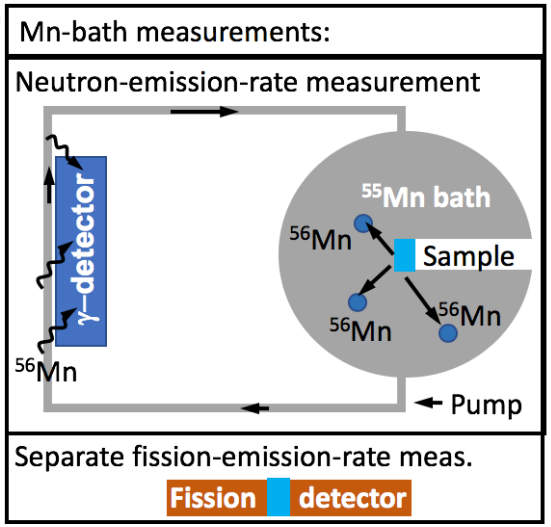
As an evaluator I would need from (n,f) cross-section measurements the following information:

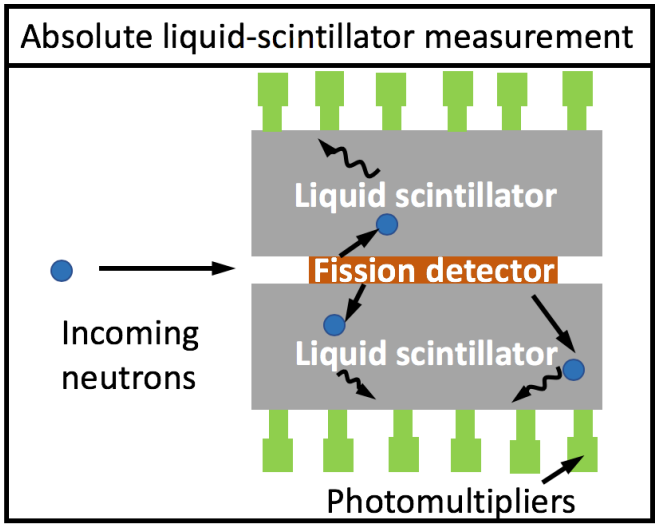
Data: E_{inc}, E_{out}, (n,f)/ ratio data, if monitor used: monitor observable + nuclear data if converted data are given, observable measured, absolute/ shape, normalization observable (if applicable)

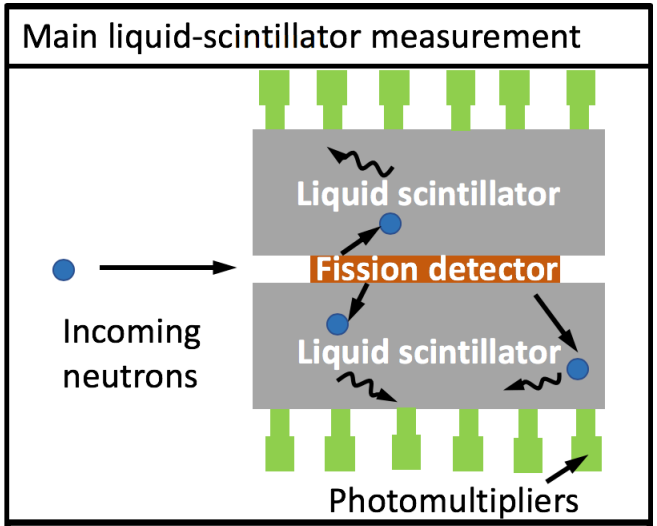
For UQ: what type of measurement (absolute, clean/ indirect ratio?), counting statistics unc., background unc., detector-efficiency unc., multiple scattering and attenuation unc., deadtime unc., nuclear-data unc., angular-distribution unc., impurity unc., energy unc., normalization unc., neutron-flux unc.

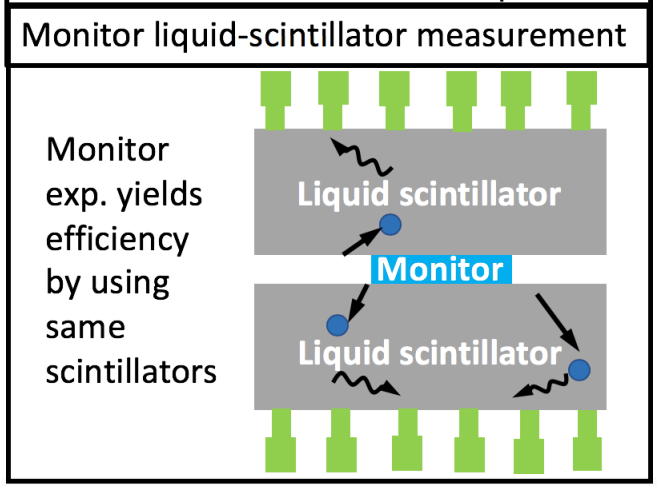
For background information: reference, impurity levels in sample, correction factors, sample thickness, known issues, known correlations to other data sets, what was corrected (background, mul. Scatt., stopping power, det. eff., sample roughness, random coincidence, angular distribution, forward boost, deadtime, impurities, neutron-flux variations, geometry), detector types, neutron-producing reaction, incoming-neutron source, target-backing material/ thickness, target diameter, facility, institute, author, methods (number-of-atoms-in-sample determination, neutron-flux/ energy determination, background, multiple scattering, detector efficiency, impurities, sample fabrication), configuration of sample

The prompt/ total-fission neutron multiplicity measures the number of neutrons emitted after fission









As an evaluator I would need from nu-bar measurements the following information:

Data: E_{inc}, nu-bar/ ratio data, if monitor used: monitor observable + nuclear data if converted data are given, observable measured, reference to PFNS, time-gate open (if gated method)

For UQ: what type of measurement, counting statistics unc., delayed gamma unc., false-fission unc., French-effect unc., PFNS unc., background unc., detector-efficiency unc., deadtime unc., nuclear-data unc., angular-distribution unc., impurity unc., energy unc., displacement-of-sample unc., sample thickness, neutron-leakage unc., Mn impurities, neutrons lost in cavity and to other reactions,

For background information: reference, impurity levels in sample, correction factors, sample thickness, known issues, known correlations to other data sets, what was corrected (background, stopping power, det. eff., sample roughness, angular distribution, forward boost, deadtime, impurities, neutron-flux variations, geometry, delayed gammas, false fissions, PFNS, displ. of sample), fission/neutron-detector types and efficiency, tank volumes, diameter of through-tube, neutron-producing reaction, incoming-neutron source, target-backing material/ thickness, target diameter, facility, institute, author, methods (energy determination, background, detector efficiency, impurities, sample fabrication), configuration of sample, flight-path length, neutron-beam size

Last thoughts:

- Some information might be straight-forward to import from existing EXFOR files (author, reference, detector type, etc.), other information can only be extracted from papers -> that would take a lot of time unless we use ML for text identification but this is very tricky and often requires expert intervention.

- Discussion point for future meetings (maybe some should be discussed at sub-meetings dedicated to observables?):
  - How to best standardize some meta-data?
  - What keywords should be used?
  - Should we go for a minimum-information structure and then a detailed one that is optional?
  - What did I forget?

Thank you for your attention!